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Epidemiological study of epilepsy in Northern India through evaluation by 3 Tesla MRI

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Abstract:

Background: Epilepsy is a common neurological disorder present in developed and developing countries. Its incidence is estimated at approximately 27.3 /1 lakh population in India and proposes a serious health problem in both rural and urban population. Diagnosis of cause of epilepsy is integral to the treatment especially in developing country like India where infectious causes lead the way and present as a curable cause of epilepsy. This study was undertaken to find the common causes of epilepsy in Indian population using 3-Tesla Magnetic Resonance Imaging (MRI). **Materials & Methods:** 150 patients of all age groups and both sexes with clinical diagnosis of epilepsy presenting were evaluated by a dedicated epilepsy protocol using 3 Tesla MRI through both traditional and advanced techniques to find out the common causes of epilepsy. **Results:** 97 male and 53 female patients were evaluated with most number of patients in the age group of 11-20 years. Granulomatous diseases formed the main pathological group with 78 (52%) patients followed by mesial temporal sclerosis, developmental malformations and tumors & tumor like conditions with 17 (11.33%), 9 (6%) and 9(6%) patients respectively. 32 (21.33%) patients had normal MR scans. 1 (0.67%) case of vascular malformations and 4 (2.67%) cases of gliosis/ encephalomalacia & periventricular leukomalacia were also diagnosed. **Conclusion:** 3 Tesla MRI provides a highly reliable method of diagnosing and following up the various causes of epilepsy using a dedicated epilepsy protocol.

Key words: Epilepsy; 3 Tesla MRI

Introduction:

Epilepsy is a common neurological disorder-affecting people worldwide. It has been considered as a public health problem by World Health Organization (WHO), the International League against Epilepsy (ILAE) [1]. According to the new (2014) definition a person is said to have epilepsy if they meet any of the following conditions:

- At least two unprovoked (or reflex) seizures occurring greater than 24 hours apart.
- One unprovoked (or reflex) seizure and a probability of further seizures similar to the general recurrence risk (at least 60%) after two unprovoked seizures, occurring over the next 10 years.
- Diagnosis of an epilepsy syndrome [2].

While the imaging evaluation of epilepsy was greatly advanced by the clinical introduction of CT in the early 1970s, further with advent of MR imaging. Today MR imaging has become the technique of choice for high-resolution structural imaging in epilepsy [3]. MRI reflects a number of parameters relating to temporal dynamics of proton nuclei responding to changing magnetic fields [4].

The role of imaging in the evaluation of epilepsy is to localize the origin of a focal seizure and identify its cause. This information is important in the treatment and prognosis of affected patients, but is vital to those with surgically treatable epilepsy. Since its development one decade ago, MR imaging has revolutionized the evaluation of epilepsy [5].

In epilepsy, the highest quality imaging is always recommended. Many studies have shown that standard MR imaging >1.5 tesla is desired and it significantly increases the diagnostic accuracy. The advent of high resolution MRI with a dedicated epilepsy protocol has significantly increased the frequency with which the pathological substrates for epilepsy are identified [6].

Various pathologic substrates of epilepsy include: inflammatory/ infectious, hippocampal sclerosis, malformations of cortical development, tumors and tumor- like conditions, prenatal and perinatal destructive injury, vascular malformations,

neurocutaneous disorders, metabolic disorders, trauma & degenerative disorders [7].

In a study in 2008, MRI at 3 Tesla performed better than 1.5 Tesla MRI in image quality, detection of structural lesions and characterization of lesions. MRI at 3T, which has a higher signal – to – noise ratio than 1.5 T MRI, is potentially more sensitive and specific at delineating epileptogenic lesions [8].
Magnetic resonance spectroscopy (MRS) provides a means of investigating cerebral metabolites and some neurotransmitters, non- invasively [9]. The concentrations of N- acetyl aspartate (NAA), creatinine and choline – containing compounds may be estimated using proton MRS.

The objective of our study was to evaluate the role of 3 Tesla MRI in clinically proven cases of epilepsy by using various conventional and advanced techniques and parameters.

The rate of presence of the various substrates of epilepsy in Indian population has not been studied in great detail previously. Neurocysticercosis, other nervous system infections, head trauma, perinatal factors, genetic problems caused by consanguinity and febrile seizures have been described as most probable causes of epilepsy in Indian population [10]. We hereby have undertaken a study to find out the most common substrates of epilepsy and their incidence, present in Indian population.

Materials and Methods

This is a prospective study done at Department of Radiodiagnosis, Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly, UP, India between December 2012 and May 2014.

Inclusion criteria in our study were to evaluate patients of both sexes and all age groups with clinically proven epilepsy referred from Medicine, Pediatric and Neurology OPDs. Relevant clinical history was taken from these patients.

Patients with contraindications to MRI like cardiac pacemakers, cochlear implants etc. and hysteria were excluded from our study.

One hundred and fifty patients were examined using 3 Tesla MR scanner (Siemens Magnetom Verio) using a circularly polarized head coil. Various conventional sequences like T1W (axial), T2W (axial), FLAIR (axial), IR (axial) and T2W oblique coronal. Few advanced sequences like SWI, DWI, MR Spectroscopy and post contrast images were also used on case to case basis.
Radiological diagnoses were made based on cumulative findings of these sequences.

Results

The present study group comprised of 150 patients ranging from 1 year to 70 years with the mean age of 24.8 years. In our study, there was no patient below 1 year of age. The study group comprised of 97 males (65%) and 53 females (35%). The largest numbers of cases were in the age group of 11 to 20 years comprising 36.67% (55/ 150) followed by the age group of 21 to 30 years with 24.6% (37/ 150) patients. Hence majority of our patients were in the age group of first two decades.
Most of the patients presented with complex partial seizure with or without generalization (114/150; 76%) followed by simple partial seizures with/without generalizations (31/150; 20.67%) and myoclonic jerks (05/150; 3.33%) All patients with mesial temporal sclerosis presented with complex partial seizure with or without generalization majority being (12/17; 70.5%) complex partial seizure without generalization. In the other groups also the predominant seizure type was complex partial seizure with/ without generalization.

In our present study the most common substrate found to be associated with epilepsy was granulomatous disease (78/150; 52.67%). 32 cases (21.33%) were found to have normal morphology on MR imaging. The other lesions found in the decreasing order of frequency were patients with mesial temporal sclerosis (17/150; 11.33%), developmental malformations (9/150; 6%), tumors and tumor like conditions (9/150; 6%), miscellaneous group (4/150; 2.67%) and vascular malformations (1/150; 0.67%).

Most common substrate found to be associated with epilepsy in present study was granulomatous disease. Most patients (56/78; 71.7%) presented with complex partials seizures with/without secondary generalization, 20/ 78; 28.2% patients presented with simple partial seizures with/ without generalizations whereas 2 patients presented with myoclonic jerks. MRI revealed neurocysticercosis in 43 patients (55%), tuberculomas in 23 patients (30%) and calcified granulomas in 12 patients (15%). In 11 (25.5%) patients, single lesions were found and in 32 patients, lesions were either in conglomeration of two to three lesions (24 cases, 55.8%) or multiple lesions (08 cases, 18.7%) in varied stages in different locations were found.

Tuberculomas may be single or multiple and can be seen anywhere in the brain parenchyma. Most of the tuberculomas in our study were conglomerated lesions. Tuberculomas were classified in three categories as non-caseating tuberculomas, solid

caseating tuberculomas and solid tuberculomas with liquefied center based on imaging findings.

Discussion

The detection of a specific imaging abnormality in a given patient with epilepsy is critical not only for classification purposes but also more importantly for prognosis.

However, CT is still the technique of choice for the investigation of patients with seizures and epilepsy under emergency conditions because it can accurately detect hemorrhage, infarctions, gross malformations or tumors, ventricular system pathologies, and lesions with underlying calcification [5]. Whereas CT imaging depicts one parameter, x-ray attenuation, MRI reflects a number of parameters relating to temporal dynamics of proton nuclei responding to changing magnetic fields [4] and is therefore much better suited for diagnostic use in complicated cases and subtle findings.

Various studies have proved the better diagnostic ability of 3 Tesla MRI than 1.5 Tesla MRI in image quality [8].

Another of the advanced applications of MRI is MR Spectroscopy. Although MR spectroscopy has been used extensively for the past 30 years in molecular physics and chemistry, its application to the study of epilepsy is relatively recent [2]. The pictorial display of MR spectroscopy information facilitates comparison of the epileptogenic zone with the remainder of the brain and provides localizing information.

The most common substrate found in our study was granulomatous disease of which neurocysticercosis was the leading cause which is a known causative disease in developing countries. Cysticercosis has been found to be a major health problem in several Asian countries [11,12]. It is the cause of epilepsy in upto 50% of Indian patients presenting with partial seizures. Calcified granulomas also form as a result of chronic infection mostly due to neurocysticercosis and more commonly due to tuberculosis in our country. Amongst the single lesions in ours study, 07 lesions were in the vesicular stage, 03 lesions were in the colloidal vesicular stage and 01 case was in the granulo- nodular stage. Among the multiple lesions, NCC in various stages of their development could be classified including- vesicular, colloidal vesicular, granulo- nodular, and mixed cases, e.g. colloid-vesicular and granulonodular lesions in same patients etc.

Tuberculomas comprised of the other major central nervous system infection with 23 cases of tuberculomas being found. They were classified as non-caseating, solid caseating and solid tuberculomas. Tuberculomas are a common source of systemic manifestation including central nervous system and their MRI features have been used to classify them [13,14]. Twelve patients had calcified granulomas, which represent chronic form of infection and are a result of host's inflammatory response [15,16].

In nearly 15-30 % of the cases of epilepsy, no specific underlying etiology is identified. In these instances, the cause may be labeled as cryptogenic if the cause is not known, or idiopathic if the epilepsy is not associated with other neurological disease [17-19].

Mesial temporal sclerosis (MTS) formed the next most commonly found pathology in our study with 17 cases consisting of 10 left-sided unilateral, 6 right-sided unilateral and 1 bilateral involvement. MTS forms the largest group of substrate among refractory epilepsy [5,20,21].

Developmental malformations constitute a relatively small group of patients presenting with epilepsy [10]. These are most commonly found in pediatric age group with youngest patient being a neonate, the oldest being a 2 year old male and 6.3 years being the mean age for the group [5]. We had 9 patients with diagnosis of various developmental malformations, which included focal dysplasia (5 cases), tuberous sclerosis (1 case), unilateral closed lip schizencephaly (1 case), heterotopic grey matter (1 case) and polymicrogyria (1 case).

9 cases of tumor and tumor like conditions were found in our study. We found 4 cases of low-grade gliomas, 3 cases of DNET, 1 case of high-grade glioma and 1 case of pleomorphic xanthoastrocytoma. These lesions tend to present most commonly in 3rd decade of life and present with complex partial seizures with/without generalization [22,23]. We had a mean age of 34.1 years for this group of disorders. Studies have shown that MRI along with its advanced techniques like spectroscopy has high sensitivity and specificity in diagnosing neoplastic diseases in brain [23-25].

The rest of the cases included 1 case of cavernous malformation, 3 cases of gliosis/ encephalomalacia and 1 case of periventricular leukomalacia. Gliosis/ encephalomalacia are known causes of seizures in patients with history of closed head injury with injury along infero – anterior regions of brain because of irregularities of the base of skull [26,27]. Periventricular leukomalacia is a known cause of epilepsy in children with history of birth asphyxia [28]. Head trauma and birth asphyxia

are known cases of epilepsy in Indian population [10].

Thus, in our study, we found that magnetic resonance imaging along with clinical history should be used in the assessment of patients who are considered surgical candidates, since the presence of focal and in particular medial temporal lobe pathology increases the chances of progression to -- successful surgical treatment.

Our study also suggests that H MRS findings are complex and dynamic. The concordance of MRS and MRI with clinical and other findings can therefore add significantly to the process of pathology. MRI is required to know the exact lesion, exact location, associated changes in the brain, planning the surgery and lateralization of the lesion in doubtful cases.

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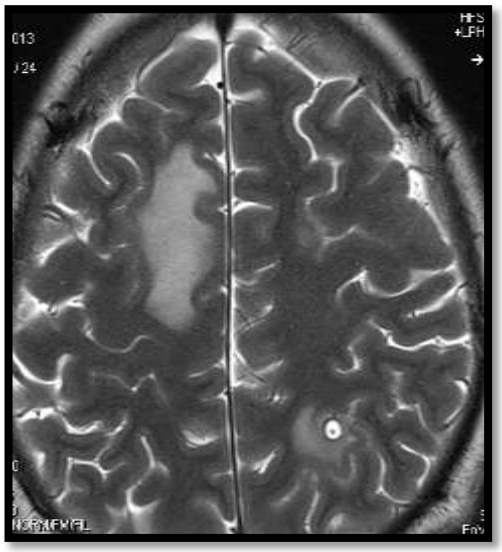

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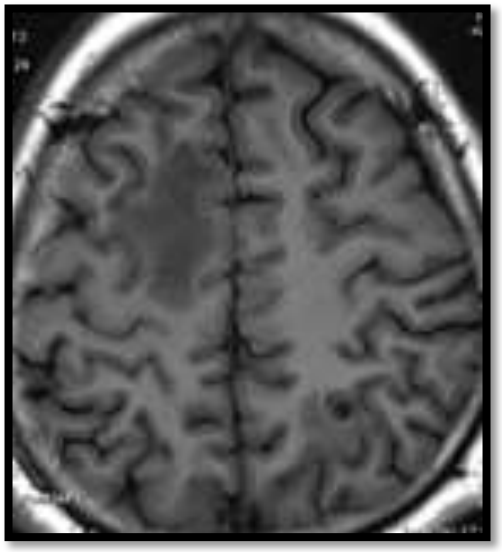

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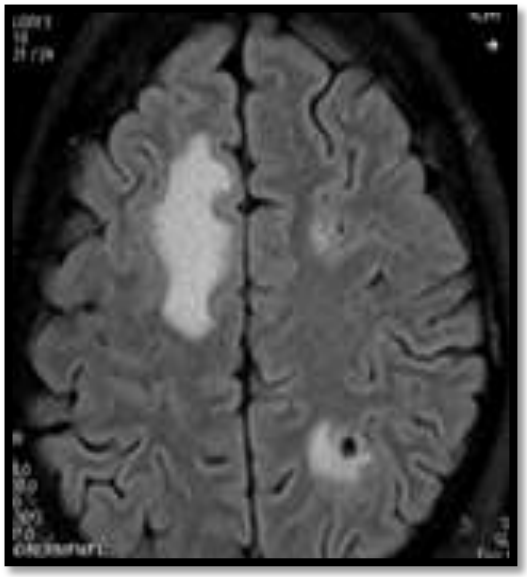
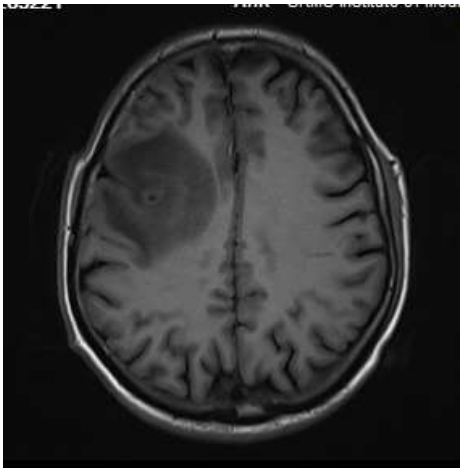


1c.

Figure 1:
NEUROCYSTICERCOSIS IN VESICULAR STAGE:

MR study showed multiple tiny cystic ring lesion in both cerebral hemisphere fronto- parietal subcortical white matter region and in the left occipital cortex, one in left cerebellar parenchyma and another in the right temporal cortex with mild perifocal edema.T2W (1a.) showed central hyperintensity with tiny hypointense nidus and a hypointense capsule.T1W(1b.) & FLAIR (1c.) showed hypointense center.



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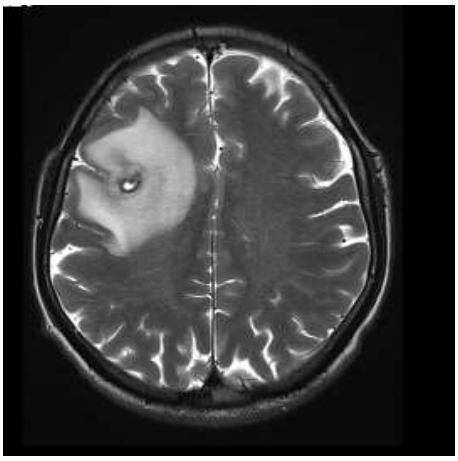

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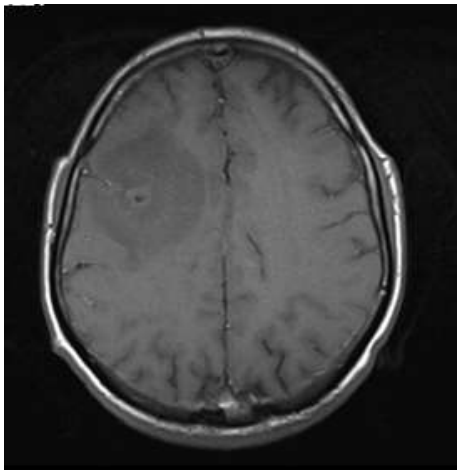

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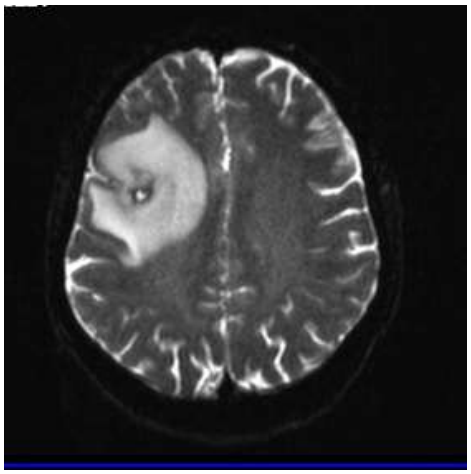

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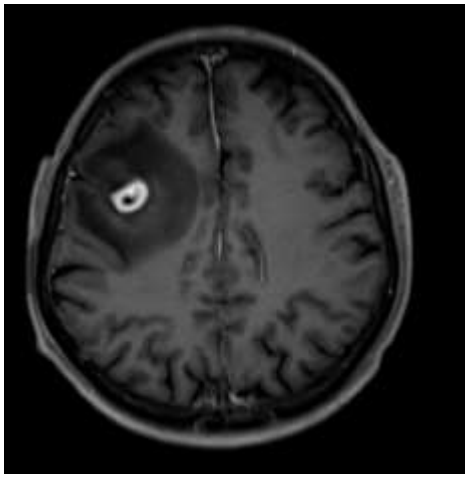
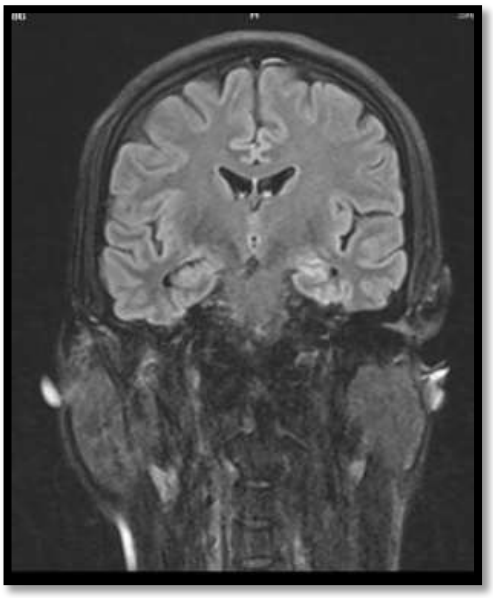


2e.

Figure 2: TUBERCULOMA WITH A LIQUEFIED CENTER:

A ring lesion in the right posterior frontal subcortical region with mild perifocal edema showing central hypointensity with peripheral hyperintensity on T1W (2a.) and central hyperintensity with peripheral hypointense rim on T2W images; (2b.) MTC showed peripheral hyperintensity (2c.) Diffusion showed restriction in the center of the cavity (2d.), and on post contrast study (2e.) thick ring enhancement of the lesion was seem.



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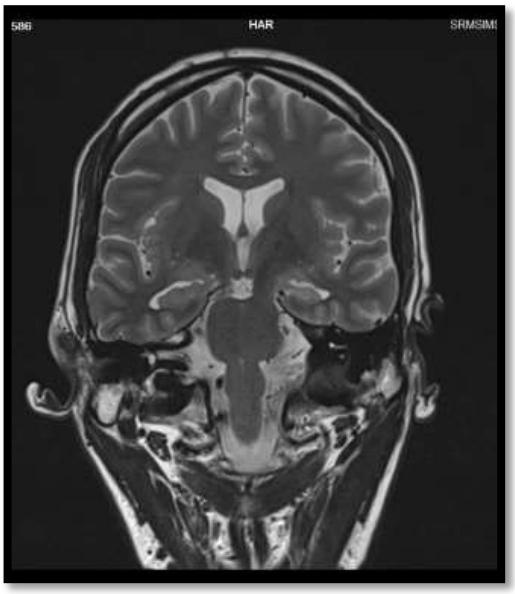

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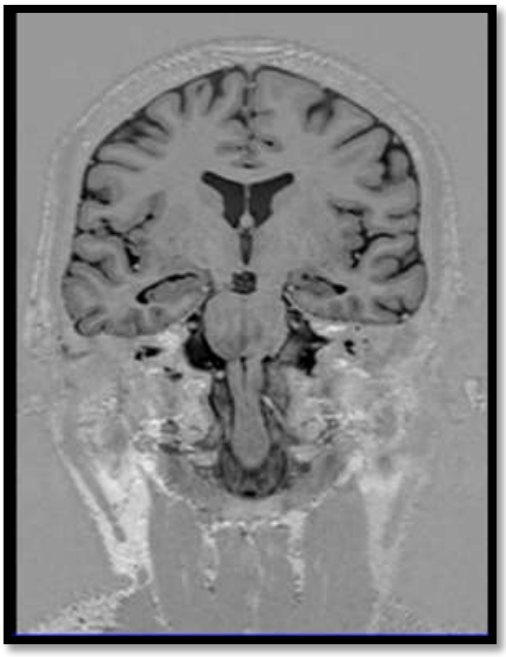
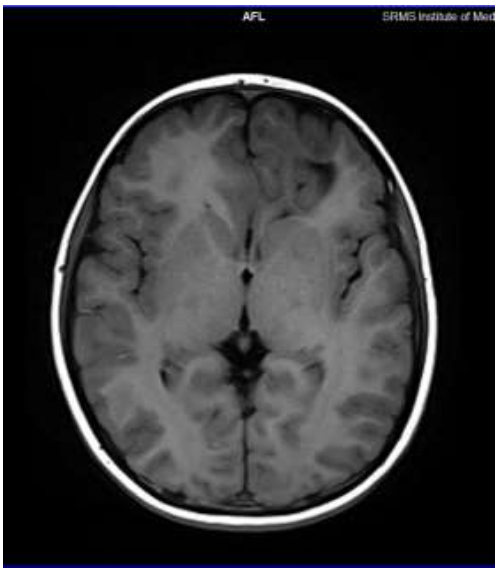


3c.

Figure 3: MESIAL TEMPORAL SCLEROSIS

Coronal FLAIR (2a.), oblique T2W (2b.) & T1W (2c.) images show diffuse increase in signal intensity with volume loss in the left hippocampus on T2 and FLAIR with loss of digitations in the head region.



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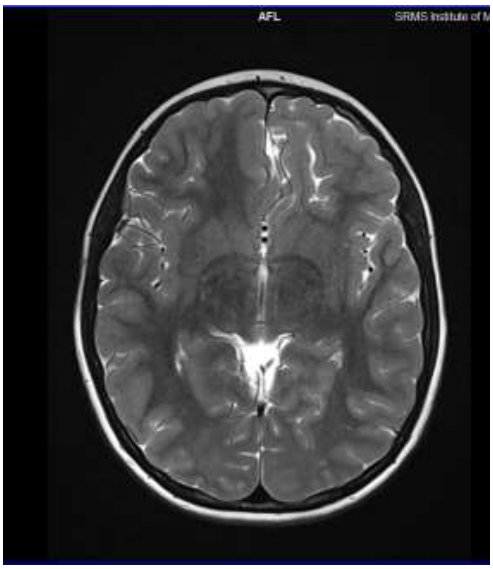

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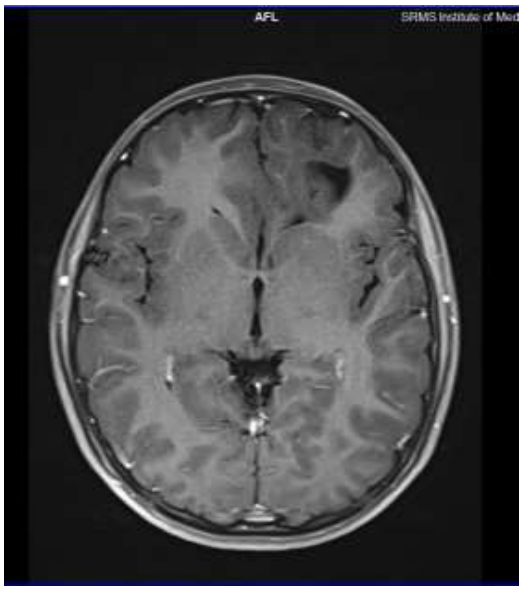

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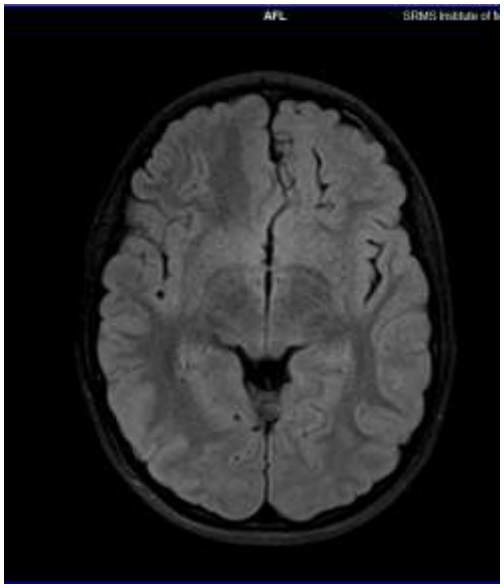
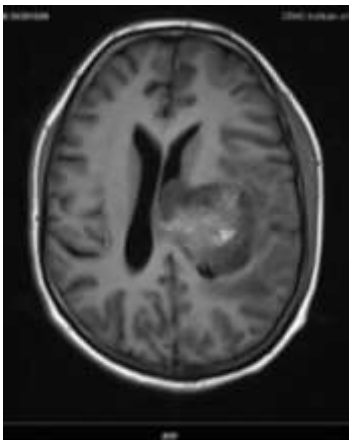


4d.

Figure 4: HETEROTOPIC GREY MATTER DISEASE:

Axial T1W (4a), T2W (4b), T1W Post contrast (4c) & FLAIR (4d) images show large nodular area of heterotopic grey matter in the left anterior frontal lobe convexity & parafalcine region. It displayed signal intensity similar to grey matter on all sequences. Post contrast study shows no obvious enhancement.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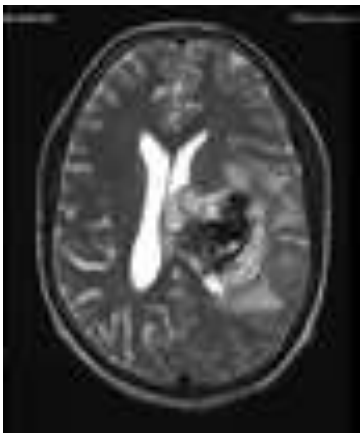
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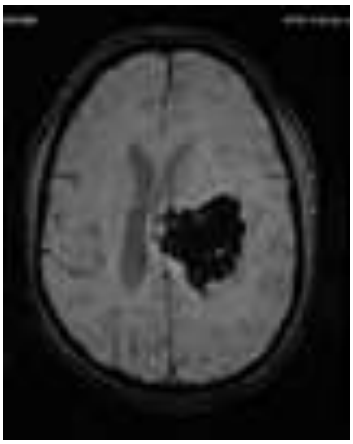
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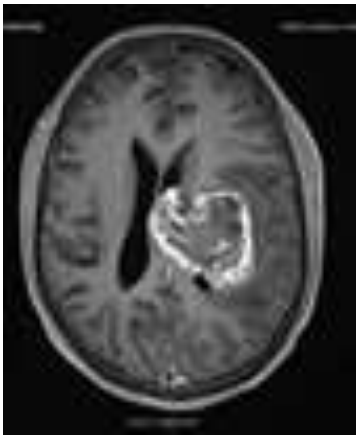
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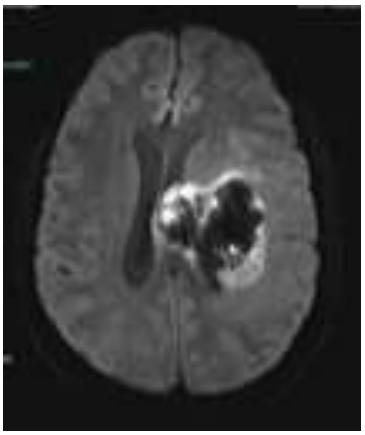
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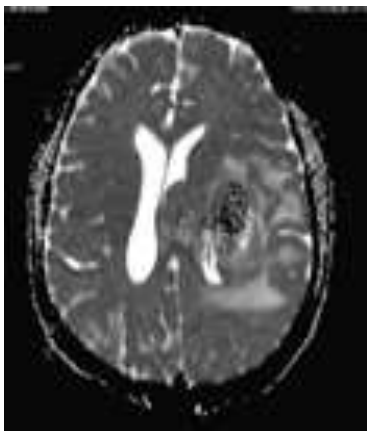
5f.

Figure 5: HIGH GRADE GLIOMA–

A large ill - defined abnormal signal intensity area in left periventricular region with large necrotic areas within, mass effect and perifocal edema. It appeared heterogeneously hypointense on **T1W (5a.)** and hyperintense on **T2W (5b.) images. Diffusion (5c & e)** shows restriction with low **ADC (5f.). T1W post contrast (5d.)** displayed peripheral enhancement of the SOL. Central hypointense area on all sequences is suggestive of hemorrhagic area.

Figure 6: Sex Distribution of Cases

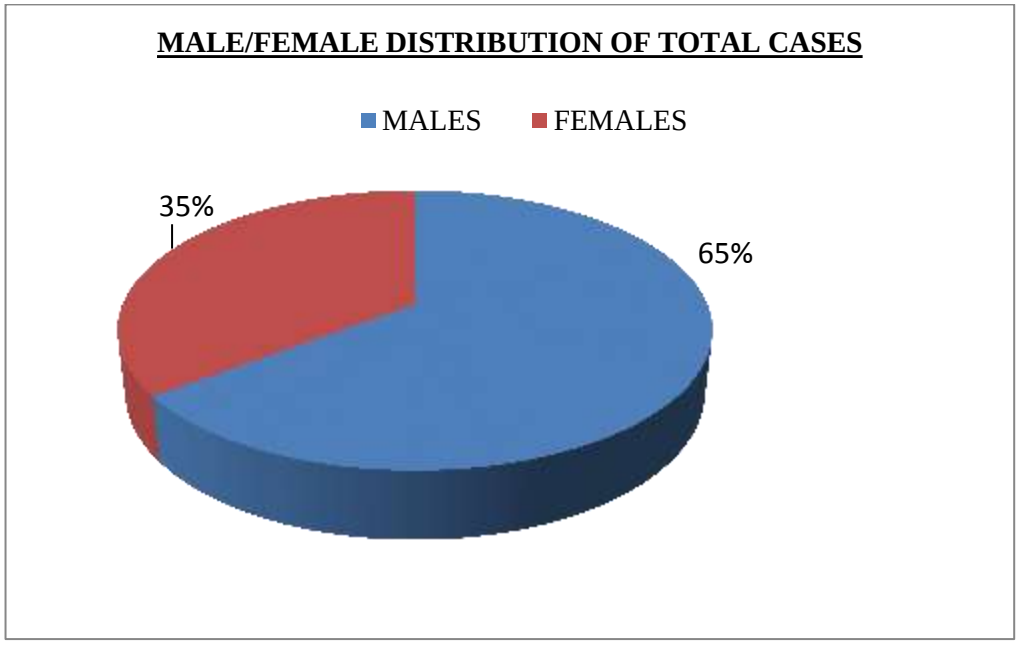

Figure 7: Pathological Distribution of Cases

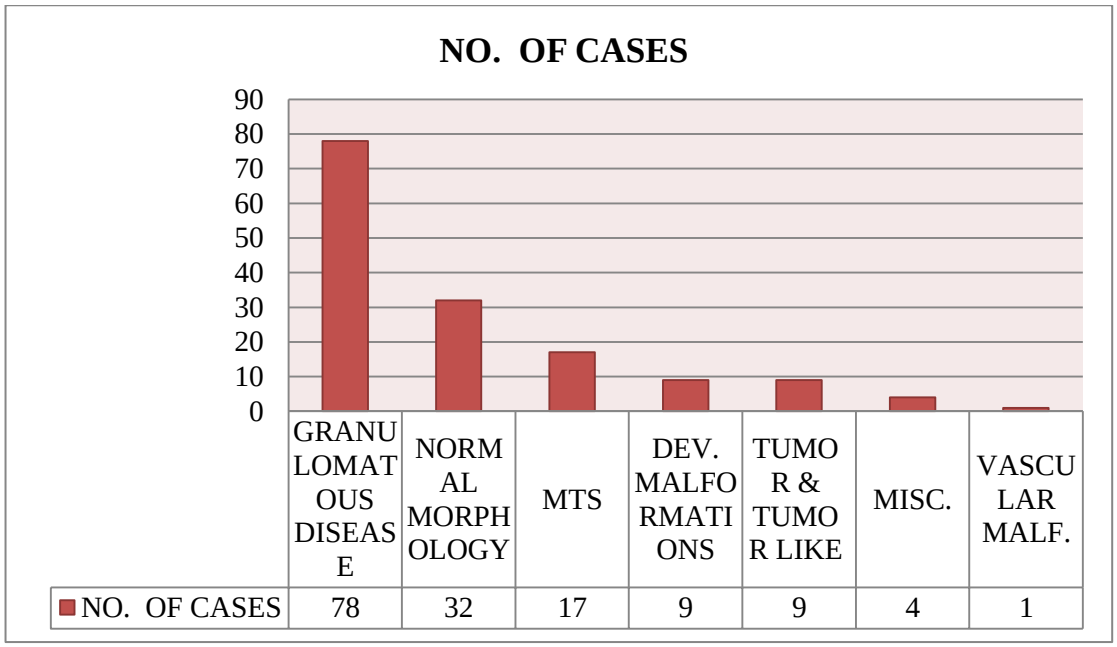

Figure 8: Distribution of Granulomatous Disease

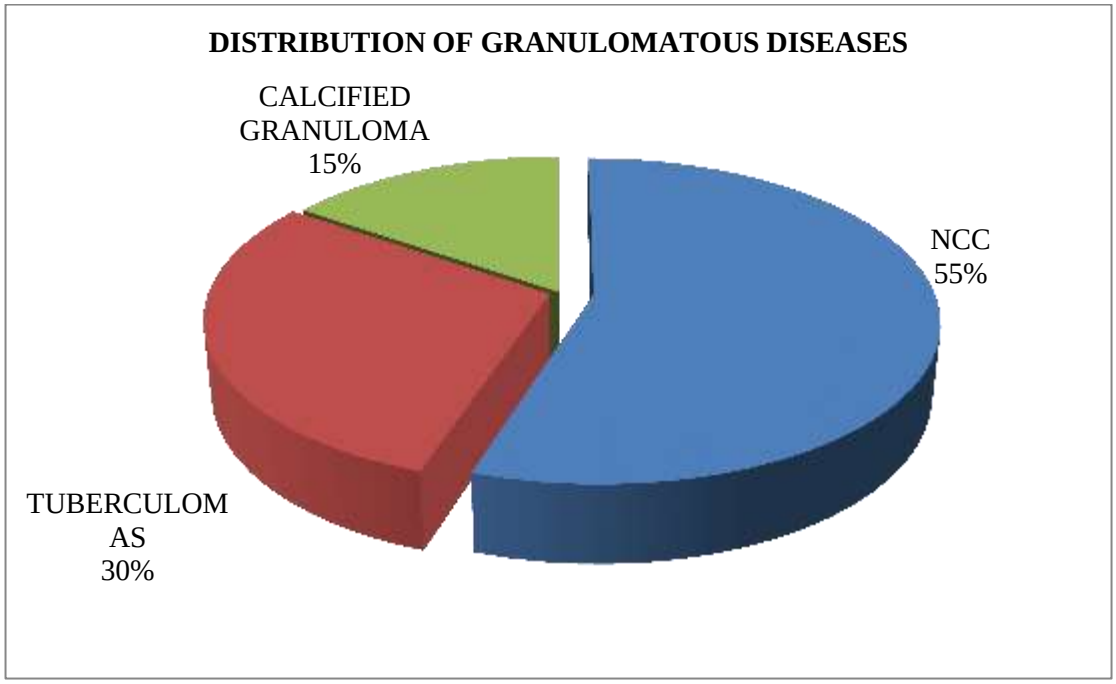

Table 1: Age/ Sex Distribution of Cases

AGE GROUP	SEX		TOTAL	PERCENTAGE (%)
	M	F		
0-10	15	05	20	13.33
11-20	33	22	55	36.67
21-30	22	15	37	24.67
31-40	10	05	15	10
41-50	08	03	11	07.33
51-60	06	01	07	04.67
61-70	03	02	05	03.33
TOTAL	**97**	**53**	**150**	**100**